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(54) **Method of, and pattern for use in, forming a sand mould, and method of producing an annular casting using the mould.**

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Method of, and pattern for use in, forming a sand mould, and method of producing an annular casting using the mould

This invention relates to sand moulds for producing an annular casting, particularly a fluid flow deflector, such as the stator of a torque converter or a compressor wheel for a turbine.

In forming such flow deflectors, a number of different manufacturing techniques have been employed. In one such prior manufacturing technique, the individual blades of the deflector were machined in segments and subsequently secured together to form the complete deflector.

In another prior manufacturing method, the blade patterns were pegged into a shell ring prior to forming a sand mould thereabout. A problem arose in such manufacture in that variation in spacing and profile occurred in the patterns so that the deflector was not completely uniform and this did not provide a completely balanced flow of the fluid.

US—A—118,693 discloses a pattern for a sand mould for the radially outer part of a tubular casting, the pattern having some radially inwardly tapering segments so that the segments can be removed from the mould upon radially inward displacement after withdrawal of a central core. This is not relevant to a sand mould pattern for an annular casting having blades extending radially between inner and outer rings.

In accordance with the present invention, a pattern for use in forming a sand mould for a one-piece annular casting having a radially inner ring, a radially outer ring and a plurality of angled blades extending in spaced annular annular array between the rings, comprises a plurality of pattern segments each having a first end portion defining a portion of the profile of one of the rings, and a second end portion defining the profile of one blade; means for supporting the pattern segments in an annular array to define cumulatively a pattern structure corresponding to the configuration of the one ring and blades, and a removable pattern ring coaxial with the array of segments to provide a pattern defining the profile for the other of the rings; the pattern segments being shaped to permit selective radially directed removal thereof from the array upon removal of the supporting means.

Thus the first end portion of at least one pattern segment may be tapered radially inwardly or outwardly to permit radially outward or inward respectively removal thereof from the array of segments upon removal of the supporting means.

The first end portions of the pattern segments may define the profile of a radially outer ring, but preferably define the profile of the radially inner ring. In the latter case radial removal of the pattern segments from the annular array will be in the radially inward direction. To facilitate this, the first end portions of adjacent ones of the segments may be tapered in opposite radial directions. Upon removal of the support for the segments, every other segment may then be removed by a radially inwardly directed movement thereof prior to removal of the other segments.

The removable pattern ring may comprise a split ring. In the illustrated embodiment, the ring defines a pattern selected to permit suitable subsequent machining of the portion of the casting defined by the pattern ring, to the final desired configuration.

The invention also includes a method of forming a sand mould for a one-piece annular casting having a radially inner ring, a radially outer ring, and a plurality of angled blades extending in a spaced annular array between the rings and utilizing a pattern as previously defined, the method comprising the steps of supporting the pattern segments in an annular array to define cumulatively a pattern structure corresponding to the configuration one of the rings and the blades; securing the removable pattern ring coaxially with the array of pattern segments; forming a sand mould about the associated parts of the pattern; discontinuing the support of the pattern segments; removing the pattern ring from the mould; and removing the pattern segments from the mould by movement thereof radially with respect to the axis of the annular array of pattern segments.

The segments may be mounted coaxially of an annular supporting surface during the mould-forming steps. Thus when the first end portions define the profile of the inner ring, the annular supporting surface may be provided on a mandrel which urges the pattern segments radially outwards and locks them in the annular array. Upon removal of the mandrel at the completion of the sand mould formations, the segments may be withdrawn sequentially into the axial space previously occupied by the mandrel.

The faces of the adjacent segments fit closely together and my additionally be locked to one another, for example by means of a locking ring engaging in a groove in the segments. In co-operation with the annular supporting surface on the mandrel or otherwise, and the removable ring, this provides a positive, fixed location of the segments of the pattern during the sand mould forming step.

Each of the pattern segments may be readily formed by identical machining operations so as to provide uniformity in the blade configuration throughout the array. The first end portion of each of the pattern segments may be machined to define selectively the inwardly and outwardly tapering configuration discussed above.

The resulting annular casting may thus comprise a totally uniform configuration to provide a completely balanced flow of fluid

therethrough. The pattern and method of forming the sand mould utilizing the pattern are extremely simple and economical while yet providing the highly improved cast structure.

The formation of a sand mould by means of a pattern in accordance with the invention is illustrated in the accompanying drawings, in which:—

Figure 1 is a perspective view of a casting;

Figure 2 is a side elevation thereof;

Figure 3 is a vertical section taken on the line 3—3 of Figure 2;

Figure 4 is a perspective view illustrating the pattern in partially assembled relationship for use in forming the sand mould to produce the casting of Figure 1;

Figure 5 is a fragmentary radial section illustrating the interlocked relationship of the inner end portions of the pattern segments;

Figure 6 is a side elevation of a pair of adjacent segments of the annular array thereof illustrated in Figure 4; and,

Figure 7 is a diametric section of the structure upon completion of the packing of the sand to form the sand mould about the pattern illustrated in Figure 4.

The manufacture of a stator 10 involves the formation of a pattern 11 for producing the stator 10 as a one-piece casting.

As shown in Figure 1, the stator includes a radially inner annular shell ring 12, a coaxial radially outer blade support ring 13, and a plurality of angled blades 14 extending in a spaced annular array between the shell and the blade support rings to define a fluid flow deflector, such as for use in a torque converter stator structure.

The blades 14 are of complex configuration and it is desirable to arrange the blades in the array illustrated in Figure 1 in accurately positioned and spaced relationship so as to provide a completely balanced and uniform stator 10. The individual blades 14 are defined by identical segments 15 of the pattern 11 which differ only in the angularity of the circumferentially opposite side faces 16 and 17 of an inner end portion 18 of the segments.

As best seen in Figures 4 and 5, inner end portions 18*a* of segments 15*a* define planar side faces 16*a* and 17*a* which converge radially outwardly from the axis 19 of the segment array. Inner end portions 18*b* of segments 15*b* define planar side faces 16*b* and 17*b* which converge radially inwardly in facial abutment with surfaces 16*a* and 17*a* of the adjacent segments 15*a*. In the illustrated embodiment, the included angle between faces 16*a* and 17*a* and, thus, between faces 16*b* and 17*b*, is approximately 60°. As shown in Figure 5, faces 16*b* and 17*b* intersect in spaced relationship to axis 19.

Segments 15*a*, as shown in Figure 6, include a first inner end portion 18*a* defined by the planar surfaces 16*a* and 17*a*, and segments 15*b* include a corresponding inner end portion defined by surfaces 16*b* and 17*b*. Each of the segments defines a similar blade portion 21 joining the respective inner end portion at 20*a*. As shown in Figures 4 and 6 the side surfaces of the inner end portions of the segments are curvilinear.

In the illustrated embodiment of Figure 5, an odd number of segments is utilized requiring the provision of a third form of segment 15*c* at one position in the annular array generally designated 22. Segment 15*c* includes an inner end portion 18*c* wherein the side surfaces 17*c* and 16*c* extend at an angle suitably to engage the counterclockwise side surface of the adjacent segment 15*b* and the clockwise side surface of the adjacent segment 15*a*.

As can be seen in Figures 4 and 5, the annular array 22 of the segments defines a complete annulus wherein the inner portions 18 define an inner continuous ring and the blades 21 are spaced apart uniformly at a uniform angle to define a fluid flow deflector pattern 23.

The annular array 22 is formed about a transversely split mandrel 25, which, as illustrated in Figure 7, has an outer arcuate configuration corresponding to the desired inside configuration of the finished stator wheel. As the segments are being installed, they are held in place by a lock ring 25*a* positioned in a groove 25*b* located in the inner portion 18 of the segments 15. They are then locked in position by the mandrel, the two parts of which urge the segments radially outwards as the parts are brought together. After the annular arrangement is completed, an outer ring 26, which forms a portion of core box 28, is brought into encircling relationship to the outer tips 24 of the blades, as shown in Figure 4. (The mandrel 25 is omitted in Figure 4 to facilitate showing of the arrangement of the segments). Outer ring 26 and core box 28 preferably comprise a split ring which includes locking means 27 for causing firm embracing of the blade tips 24 in the annular array of the segments.

After the pattern is assembled on the mandrel 25 and with the outer ring 26 installed, as shown in Figure 7, moulding sand 29 may be packed around the pattern and subsequently cured to form the desired sand mould M in which the stator 10 is cast.

Sand mould M is then removed from the core box 28 and mandrel 25 and split ring 26 are removed. Removal of mandrel 25 from annular array 22 permits the removal of the segments 15 sequentially from the annular array. More specifically, upon removal of mandrel 25, segments 15*a* may be removed by a radially inward withdrawal thereof from the annular array as permitted by the inwardly widening side surface configuration. Upon removal of segments 15*a*, segments 15*b*, and segment 15*c* when used, may then be removed to complete the removal of the pattern from the sand mould for subsequent casting of the stator 10 in the formed mould.

As the inner portions 18 of the respective segments effectively define a continuous annular ring portion of the pattern, as seen in Figures 4 and 5, the sand mould correspondingly defines a continuous ring cavity for defining the shell 12 of the stator 10, seen in Figure 1. Further, as each of the segment blade portions 21 was accurately and positively positioned in the annular array 22, the resultant cast blades 14 are similarly accurately spaced and positioned in the stator 10.

As illustrated in Figure 3, the configuration of the split ring 26 may not correspond exactly to the desired final configuration of the blade support 13. Thus, illustratively, the outer portion of the casting may comprise a rectangular section ring which may be suitably machined to the final configuration of the blade support 13, as shown in Figure 3.

As further illustrated in Figure 3, the shell 12 may be further machined at its opposite ends 30 and 31, as desired.

The casting produced with the pattern of the present invention provides an improved uniform, accurately configured complex-shaped structure which is adapted for use in a wide range of industrial applications, such as the stator of a torque converter wherein it is desirable to provide accurate, uniform blade deflectors at low cost.

As the pattern for the casting mould is made up of a plurality of readily repeatable machined segments, high accuracy in the configuration of the pattern and, as a result, the configuration of the casting made from the mould formed by the pattern, is obtained.

As indicated above, the pattern may provide either an even number of blades or an odd number of blades in the cast stator as desired. As will be obvious to those skilled in the art, where an even number of blades is desired, the segment 15*c* is omitted and the circumferential extent of each of the segments 15*a* and 15*b* correspondingly increased to form the continuous annular array defining the shell portion of the stator.

The invention permits the production of sand moulds for castings in such relatively complex-shaped castings as stator 10 by numerical control machining steps in forming the individual segments. The interlocking angle of the side surfaces of the segments assures that the blade portions thereof are effectively accurately retained while the moulding stand is being packed around the pattern, thereby assuring a uniform blade arrangement. Where the stator is utilized as a torque converter stator, such uniform stator configuration provides a highly desirable balanced flow of fluid through the diverter means.

Claims

1. A pattern for use in forming a sand mould for a one-piece annular casting (10) having a radially inner ring (12), a radially outer ring (13) and a plurality of angled blades (14) extending in a spaced annular array (22) between the rings (12, 13), the pattern comprising a plurality of pattern segments (15) each having a first end portion (18) defining a portion of the profile of one of the rings (12), and a second end portion (21) defining the profile of one blade; means (25) for supporting the pattern segments in an annular array (22) to define cumulatively a pattern structure corresponding to the configuration of the one ring and blades; and a removable pattern ring (26) coaxial with the array of segments to provide a pattern defining the profile for the other of the rings (13); the pattern segments (15) being shaped to permit selective radially directed removal thereof from the array (22) of pattern segments upon removal of the supporting means (25).

2. A pattern according to claim 1, wherein the first end portion (18) of at least one pattern segment (15) is tapered in the radial direction to permit radially directed removal thereof from the array (22) of segments upon removal of the supporting means (25).

3. A pattern according to claim 1 or claim 2, wherein the first end portions (18) of the pattern segments (15) define the profile of the radially inner ring.

4. A pattern according to claim 3, wherein the first end portions (18*a*, 18*b*) of adjacent ones of the segments are tapered in opposite radial directions.

5. A pattern according to any one of the preceding claims, wherein the supporting means (25) comprises a split mandrel located radially within the segments.

6. A pattern according to any one of the preceding claims, wherein the segments, (15*a*, 15*b*, 15*c*) are of three specific forms which differ only in the angularity of circumferentially opposite side faces (16) of the first end portions (18) thereof.

7. A pattern according to any one of the preceding claims, wherein the removable pattern ring (26) comprises a split ring.

8. A pattern according to claim 2, wherein the first end portion (18) of the at least one segment is tapered to widen radially outwardly.

9. A pattern according to any one of the preceding claims, wherein the circumferentially opposite side faces of the first end portions (18) of adjacent segments (15) define complementary curvilinear surfaces.

10. A pattern according to any one of the preceding claims, including annular locking means (25*a*) for holding the segments in place during installation on the supporting means (25).

11. A method of forming a sand mould (M) for a one piece annular casting (10) having a radially inner ring (12), a radially outer ring (13), and a plurality of angled blades (14) extending in a spaced annular array (22) between the rings (12, 13) and utilizing a pattern according to any

one of the preceding claims, the method comprising the steps of supporting the pattern segments (15) in an annular array (22) to define cumulatively a pattern structure corresponding to the configuration one of the rings (2) and the blades (14); securing the removable pattern ring (26) coaxially with the array (22) of pattern segments; forming a sand mould (M) about the associated parts of the pattern (11); discontinuing the support of the pattern segments (15); removing the pattern ring (26) from the mould; and removing the pattern segments (15) from the mould by movement thereof radially with respect to the axis (19) of the annular array (22) of pattern segments.

12. A method according to claim 11, wherein the pattern segments are supported by providing an annular supporting surface (25) and mounting the pattern segments (15) coaxially of the supporting surface.

13. A method according to claim 12, when utilising a pattern according to claim 3, wherein the annular supporting surface is provided on a mandrel (25) which urges the pattern segments (15) radially outwards and locks them in the annular array.

14. A method according to any one of claims 11 to 13, wherein the pattern segments (15) have been formed by machining.

15. A method of producing an annular casting wherein the casting is cast in a sand mould which has been formed by a method according to any one of claims 11 to 14, whereafter the portion of the casting defined by the pattern ring is subjected to machining.

Patentansprüche

1. Ein Muster zur Verwendung bei der Ausbildung einer Sandform für ein einstückiges ringförmiges Gußteil (10) mit einem sich radial erstreckenden Innenring (12), einem radial äußeren Ring (13) und einer Vielzahl von angewinkelten sich in einer mit Abstand angeordneten Ringanordnung (22) zwischen den Ringen (12, 13) erstreckenden Schaufeln (14), wobei das Muster eine Vielzahl von Mustersegmenten (15) aufweist, deren jedes einen ersten Endteil (18) und einen zweiten Endteil (21) aufweist, wobei der erste Endteil (18) einen Teil des Profils eines der Ringe (12) bildet, während der zweite Endteil (21) das Profil einer Schaufel definiert, und wobei ferner Mittel (25) vorgesehen sind, um die Mustersegmente in einer Ringanordnung (22) zu tragen, um kumulativ eine Musterstrucktur zu definieren, die der Konfiguration des einen Rings und der Schaufeln entspricht, und wobei ferner ein entfernbarer Musterring (26) koaxial mit der Anordnung aus den Segmenten vorgesehen ist, um ein Muster vorzusehen, welches das Profil für den anderen der Ringe (13) definiert, und wobei die Mustersegmente (15) ferner derart geformt sind, daß die wahlweise radial gerichtete Entfernung derselben aus der Anordnung (22) der Mustersegmente nach Entfernung der Tragmittel (25) zulässig ist.

2. Muster nach Anspruch 1, wobei der erste Endteil (18) von mindestens einem Mustersegment (15) in Radialrichtung verjüngt ist, um die radial gerichtetete Entfernung desselben aus der Anordnung (22) von Segmenten nach Entfernung der Tragmittel (25) zu gestatten.

3. Muster nach Anspruch 1 oder 2, wobei die ersten Endteile (18) der Mustersegmente (15) das Profil des radial inneren Rings definieren.

4. Muster nach Anspruch 3, wobei die ersten Endteile (18a, 18b) von benachbarten Segmenten in entgegengesetzten Radialrichtungen verjüngt sind.

5. Muster nach einem der vorhergehenden Ansprüche, wobei die Tragmittel (25) einen gespaltenen Dorn angeordnet radial innerhalb der Segmente aufweisen.

6. Muster nach einem der vorhergehenden Ansprüche, wobei die Segmente (15a, 15b, 15c) drei spezifische Formen besitzen, die nur hinsichtlich der Winkelmäßigkeit der umfangsmäßig entgegengesetzt liegenden Seitenflächen (16) der ersten Endteile (18) sich unterscheiden.

7. Muster nach einem der vorhergehenden Ansprüche, wobei der entfernbare Musterring (26) ein unterteilter Ring ist.

8. Muster nach Anspruch 2, wobei der erste Endteil (18) von mindestens einem Segment verjüngt ist, um sich radial nach außen zu erweitern.

9. Muster nach einem der vorhergehenden Ansprüche, wobei die umfangsmäßig entgegengesetzt liegenden Seitenflächen der ersten Endteile (18) von benachbarten Segmenten (15) komplementäre gekrümmte Oberflächen definieren.

10. Muster nach einem der vorhergehenden Ansprüche mit ringförmigen Verriegelungsmitteln (25a) zur Halterung der Segmente an ihrem Platz während des Einbaus auf den Tragmitteln (25).

11. Verfahren zur Ausbildung einer Sandform (M) für ein einstückiges Ringgußstück (10) mit einem radial inneren Ring (12), einem radial äußeren Ring (13) und einer Vielzahl von winkelmäßig angeordneten Schaufeln (14), die sich in einer mit Abstand angeordneten Ringanordnung (22) zwischen den Ringen (12, 13) erstrecken und wobei ein Muster gemäß einem der vorhergehenden Ansprüche verwendet wird, wobei das Verfahren folgende Schritte vorsieht:

Tragen der Mustersegmente (15) in einer Ringanordnung (22) zur kumulativen Definition einer Musterstrucktur entsprechend der Konfiguration eines der Ringe (12) und der Schaufeln (14),

Befestigung des entfernbaren Musterrings (26) koaxial mit der Anordnung (22) der Mustersegmente,

Ausbildung einer Sandform (M) um die assoziierten Teile des Musters (11),
Beendigung der Halterung der Mustersegmente (15),
Entfernung des Musterrings (26) aus der Form, und
Entfernung der Mustersegmente (15) aus der Form durch deren Radialbewegung bezüglich der Achse (19) der Ringanordnung (22) der Mustersegmente.

12. Verfahren nach Anspruch 11, wobei die Mustersegmente dadurch getragen werden, daß man eine Ringtragoberfläche (25) vorsieht und Befestigung des Mustersegmente (15) koaxial zur Tragoberfläche.

13. Verfahren nach Anspruch 12 bei Verwendung eines Musters nach Anspruch 3, wobei die Ringtragoberfläche auf einem Dorn (25) vorgesehen ist, der die Mustersegmente (15) radial nach außen drückt und diese in der Ringanordnung verriegelt.

14. Verfahren nach einem der Ansprüche 11 bis 13, wobei die Mustersegmente (15) durch Bearbeitung gebildet sind.

15. Verfahren zur Herstellung eines Ringgußteils, wobei das Gußteil in eine Sandform ausgebildet durch ein Verfahren gemäß einem der Ansprüche 11 bis 14 gegossen wird, woraufhin der durch den Musterring definierte Teil des Gußteils einer Bearbeitung ausgesetzt wird.

Revendications

1. Modèle destiné à être utilisé pour former un moule de sable pour une pièce moulée annulaire monobloc (10) ayant un anneau radialement intérieur (12), un anneau radialement extéreiur (13), et un certain nombre de lames inclinées (14) s'étendant suivant un arrangement annulaire (22) espacé entre les anneaux (12, 13), le modèle comprenant un certain nombre de segments de modèle (15) ayant chacun une première partie d'extrémité (18) définissant une partie du profil de l'un des anneaux (12), et une seconde partie d'extrémité (21) définissant le profil d'une lame; un moyen (25) pour supporter les segments de modèle suivant un arrangement annulaire (22) afin de définir cumulativement une structure de modèle correspondant à la configuration de l'un des anneaux et des lames; et un anneau de modèle amovible (26) coaxial avec l'arrangement de segments afin de produire un modèle définissant le profil pour l'autre anneau (13); les segments de modele (15) étant profilés pour permettre leur enlèvement sélectif suivant une direction radiale à partir de l'arrangement de segments (22) après l'enlèvement du moyen de support (25).

2. Modèle selon la revendication 1, dans lequel la première partie d'extrémité (18) d'au moins un segment de modèle (15) concourt dans la direction radiale pour permettre un enlèvement dans une direction radiale de celui-ci à partir de l'arrangement de segments (22) après l'enlèvement du moyen de support (25).

3. Modèle selon la revendication 1 ou 2, dans lequel les premières parties d'extrémité (18) des segments de modèle (15) définissent le profil de l'anneau radialement intérieur.

4. Modèle selon la revendication 3, dans lequel les premières parties d'extrémités (18*a*, 18*b*) des segments adjacents concourent dans des directions radiales opposées.

5. Modèle selon l'une quelconque des revendications précédentes, dans lequel le moyen de support (25) comprend un mandrin fendu placé radialement dans les segments.

6. Modèle selon l'une quelconque des revendications précédentes, dans lequel les segments (15*a*, 15*b*, 15*c*) ont trois formes spécifiques qui ne diffèrent que dans l'inclinaison des faces latérales circonférentiellement opposées (16) de leurs premières parties d'extrémité (18).

7. Modèle selon l'une quelconque des revendications précédentes, dans lequel l'anneau de modèle amovible (26) comprend une bague fendue.

8. Modèle selon la revendication 2, dans lequel la première partie d'extrémité (18) de l'un au moins des segments concourt de manière à s'élargir radialement vers l'extérieur.

9. Modèle selon l'une quelconque des revendications précédentes, dans lequel les faces latérables circonférentiellement opposées des premières parties d'extrémité (18) des segments adjacents (15) définissent des surfaces curvilignes complémentaires.

10. Modèle selon l'une quelconque des revendications précédentes, comprenant des moyens de blocage (25*a*) pour tenir les segments en place durant l'installation sur le moyen de support (25).

11. Procédé pour former un moyle de sable (M) pour une pièce moulée annulaire monobloc (10) ayant un anneau radialement intérieur (12), un anneau radialement extérieur (13), et un certain nombre de lames inclinées (14) s'étendant suivant un arrangement annulaire (22) espacé entre les anneaux (12, 13) et utilisant un modèle selon l'une quelconque des revendications précédentes, ce procédé comprenant les étapes consistant à supporter les segments de modèle (15) suivant un arrangement annulaire (22) pour définir cumulativement une structure de modèle correspondant à la configuration de l'un des anneaux (12) et des lames (14); à fixer l'anneau de modèle amovible (26) coaxialement avec l'arrangement (22) de segments de modèle; à former un moule de sable (M) autour des parties associées du modèle (11); à interrompre le support des segments de modèle (15); à enlever l'anneau de modèle (26) du moule; et à enlever les segments de modèle (15) du moule par un mouvement de ceux-ci radialement par rapport à l'axe

(19) de l'arrangement annulaire (22) des segments de modèle.

12. Procédé selon la revendication 11, dans lequel les segments de modèle sont supportés en produisant une surface de support annulaire (25) et en montant les segments de modèle (15) coaxialement avec la surface de support.

13. Procédé selon la revendication 12 quand il utilise un modèle selon la revendication 3, dans lequel la surface de support annulaire est produite sur un mandrin (25) qui sollicite les segments de modèle (15) radialement vers l'extérieur et qui les veroruille dans l'arrangement annulaire.

14. Procédé selon l'une quelconque des revendications 11 à 13, dans lequel les segments de modèle (15) ont été formés par un usinage.

15. Procédé pour produire une pièce moulée annulaire dans lequel la pièce moulée et coulée dans un moule de sable qui a été formé par un procédé selon l'une quelconque des revendications 11 à 14, après quoi, la partie de la pièce moulée définie par l'anneau de modèle est soumise à un usinage.

FIG. 1

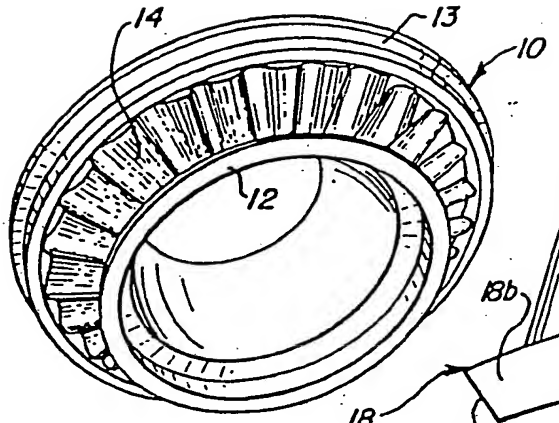


FIG. 6

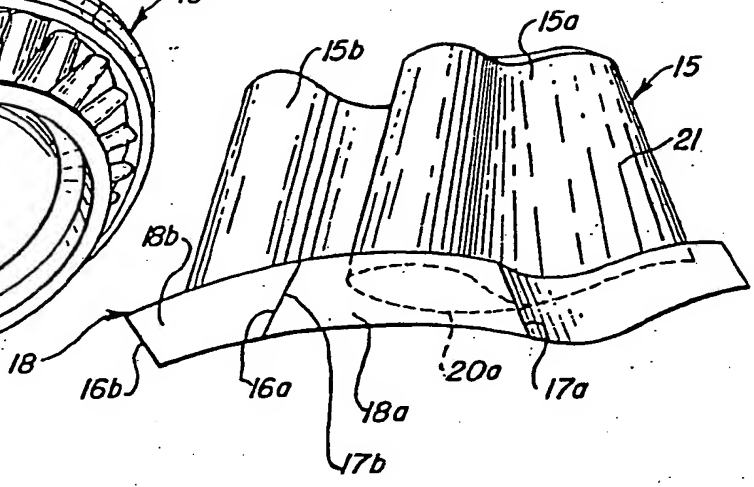
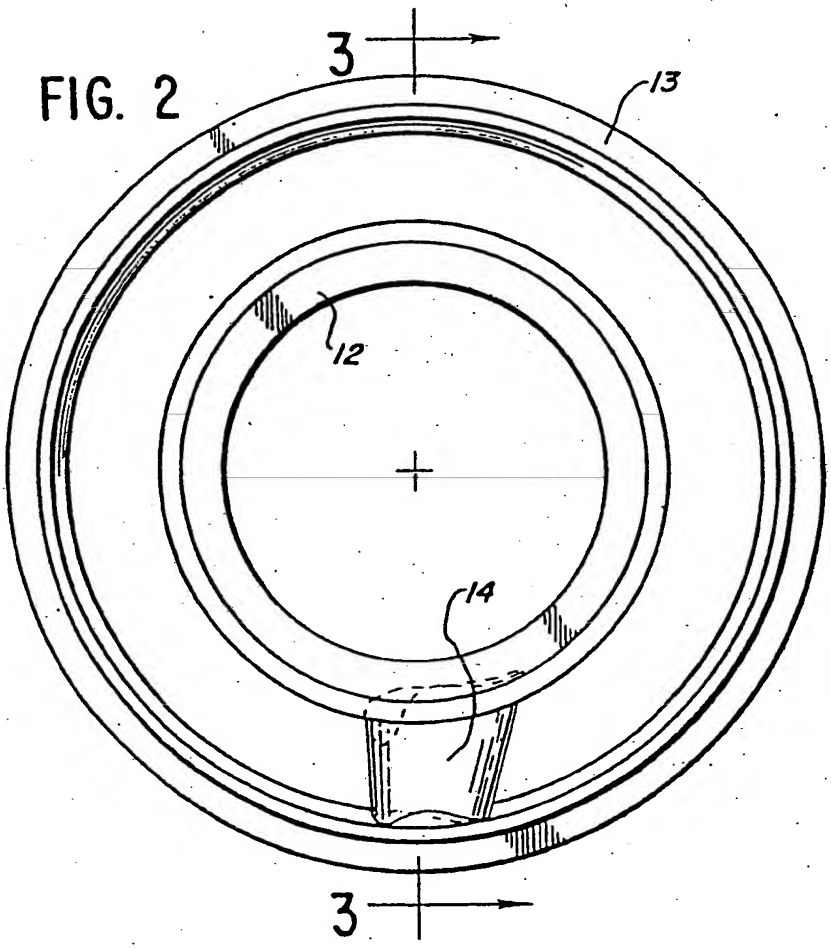


FIG. 2



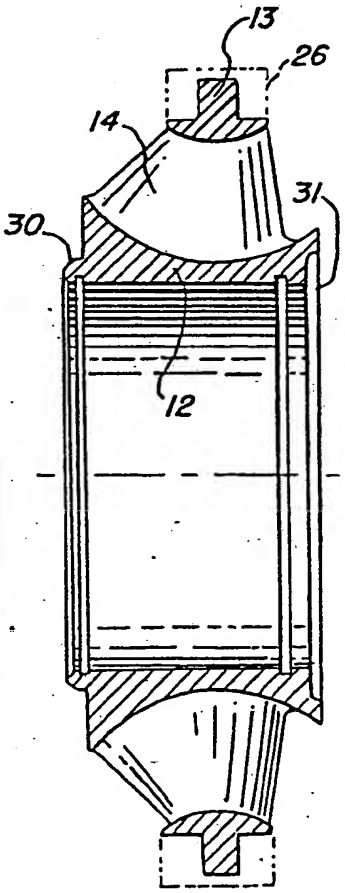


FIG. 3

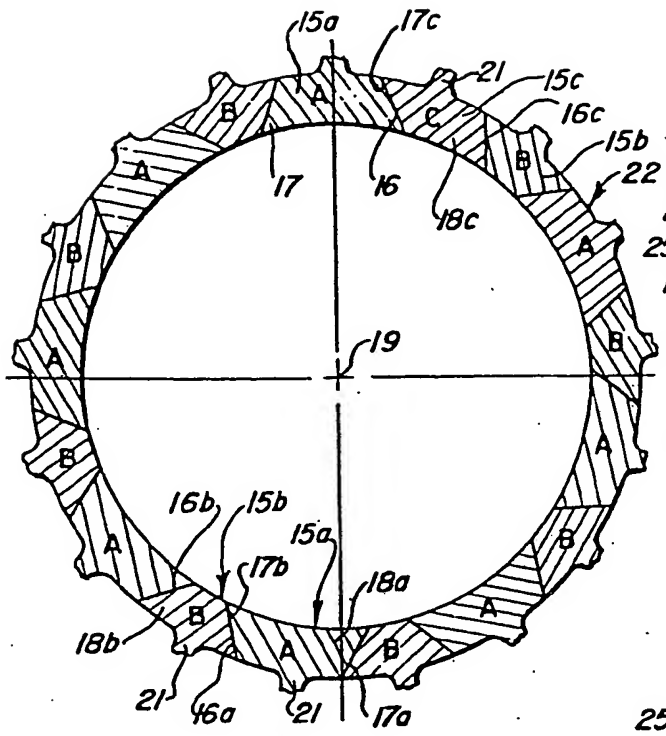


FIG. 5

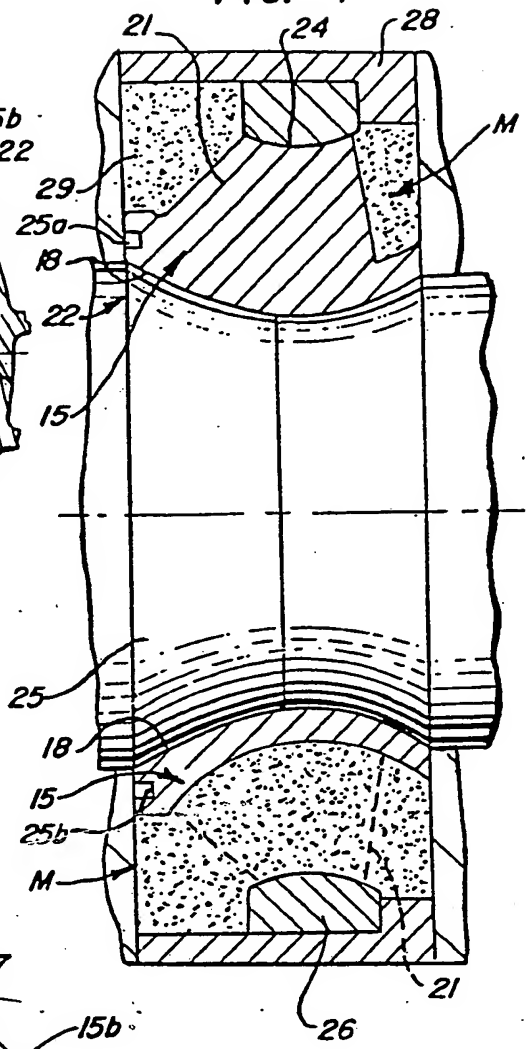


FIG. 7

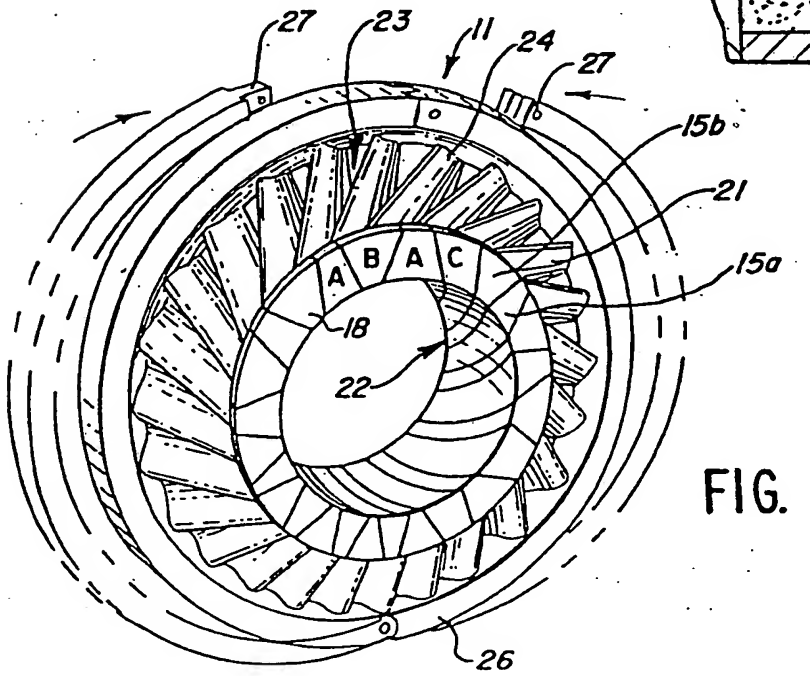


FIG. 4